Responses to Technical Corrections

Dear Dr. Collier,

Thank you for accepting our manuscript for publication in TC subject to addressing technical corrections. We appreciate your diligent handling of the paper and the efforts of the reviewers in providing valuable feedback. We have addressed all the suggestions, questions, and corrections in this final version. Please find a detailed response to the comments below, with the comments in black and our corresponding replies in blue.

Thank you again for your time and effort.

Sincerely,
Christina Draeger on behalf of all coauthors

Thank you for your revised manuscript and responses, as well as for your patience with the editorial decision. I am pleased to accept your manuscript for publication in TC subject to addressing the following technical corrections:

1. Line 38: can you add a reference for process-based models being more reliable? Otherwise, consider rephrasing along the lines of these models not relying on the temporal stationarity of melt factors.

Rephrased to:

Line 37: Since these models capture the physical processes that are happening at the glacier surface, they do not rely on the temporal stationarity of melt factors, as is the case in temperature-index models. However, they require a larger number of input variables, including incoming shortwave and longwave radiation, temperature, relative humidity, wind speed and precipitation.

2. Line 90: consider rephrasing to "on the order of a kilometre (e.g., Erler...)" as there are decadal applications of WRF over mountainous regions at less than 4-km grid spacing in the convection-permitting climate modelling literature.

Rephrased accordingly.

3. Consider making the REF namelist available via open repository so that the workflow and model configuration (for example, in which domains terrain shading is applied) are reproducible.

The REF namelist will be made available.

4. From my memory, the glacier subroutines in Noah and Noah-MP did not differ significantly. To help interpret the sensitivity results, consider adding a sentence to the methods about the difference in how glacier surfaces are treated between the two LSMs. Can you also please explicitly state if the albedo parameters were only adjusted in the Noah-MP (line 442) but not in the Noah LSM?

Added:

Line 221: Noah-MP, which is a more sophisticated version of Unified Noah, includes multiple snow layers, representing percolation, retention, and refreezing of meltwater within the snowpack rather than in the snow–atmosphere and snow–soil interface as is the case with Unified Noah (Suzuki and Zupanski, 2018).

Line 457: In both land surface models, the glacier surface albedo is calculated as a weighted average of land ice albedo and snow albedo based on snow cover fraction (He et al., 2023).

Line 450: No changes were applied to the albedo representations within Unified Noah.

5. Could you provide a justification for using the BMJ cumulus scheme in all domains, even the km-scale ones? Does this scheme have a scale-aware component?

Added:

Line 536: We note that none of the cumulus schemes used in this study is scale-aware. Theoretically, cumulus parameterizations are only valid for coarse spatial grids of more than 10 km in order to release latent heat in the convective columns (Zhang et al., 2012). The parameterizations can also help to trigger mesoscale convection (5–10 km). For a grid spacing of 3–5 km or less, it is recommended to switch "off" the cumulus schemes as the model can explicitly resolve deep convection and simulate convective storms (Skamarock and Klemp, 2008). However, it has also been recommended to keep this parameterization "on" for grid spacing of 1–10 km to avoid accumulated energy at grid points (Gerard, 2007). The cumulus parameterization scheme has been consistently turned "off" below 3 km in previous glacier studies (e.g., Mölg and Kaser, 2011; Collier et al., 2013, 2015; Aas et al., 2016). Between 3 and 5 km, some studies used the cumulus parameterization scheme (e.g., Mölg and Kaser, 2011), while others explicitly resolved deep convection without parameterization (e.g., Aas et al., 2016).

6. Line 304: Unrepresentative surface albedo in the ablation zone was also demonstrated by Collier et al. (2013). It would be worth mentioning (unless I missed it) that although observed albedo is used in the SEB model, the (poorly) simulated albedo will still impact the near-surface meteorological forcing fields.

Rephrased to:

Line 306: The discrepancy between WRF and the observed albedo on glaciers, especially in the ablation zone, has also been noted in previous glacier studies (Collier et al., 2013; Eidhammer et al., 2013)

Added:

Line 309: We note that while we incorporate observed albedo into the SEB model, the inaccurately simulated albedo in WRF still influences the near-surface meteorological forcing fields.

Thank you for your efforts and congratulations on an interesting contribution to the glacier SEB & MB modelling community!

Best regards,
Emily Collier